



Cleanfire[®] HR_x[™] Oxy-fuel Burner

Glass melting technology with expanded functionality and flexibility for unmatched performance

Air Products creates long-term value through sustainable glass melting technologies. We provide industry-leading solutions, guided by society's challenges and fueled by innovation.

Three decades of Leadership in Combustion Technology

- Lancing
- Boosting
- Full conversion
- Emergency services
- CFD modeling



Integrated Systems for High Efficiency Sustainable Glass Melting

- Low emissions
- High efficiency
- High glass quality
- Integrated O₂ production
- Flexible fuel options, including hydrogen blends
- Hydrogen production and supply mode options



Strong Pipeline of Decarbonization Solutions

- Energy recovery
- CO₂ capture
- Power generation
- Gasification



Oxy-fuel Combustion

Customers have relied on our line of industry-leading Cleanfire® oxy-fuel burners for decades. Oxy-fuel combustion has proven benefits over air-fuel combustion, including lower capital cost, higher fuel efficiency, and reduced NO_x. You can expect even more benefits with Air Products' patent pending Cleanfire® HR_x™ burner. The HR_x burner harnesses the power of oxygen staging by allowing the user to control both the magnitude and location of up to 95% of the combustion oxygen which provides both higher melting efficiency and foam reduction—resulting in significant energy and emissions reductions and improved product quality.

Key HR_x Technology Features

The HR_x burner offers you expanded functionality and flexibility with unmatched performance in your glass melting furnace; whether as a boost burner to complement the operation of an air-fuel furnace—or in a full oxy-fuel furnace to increase fuel efficiency, lower NO_x emissions, or reduce foam.



Key features include:

- On-burner valves for easy adjustment of oxygen staging location and magnitude
- Extremely high flame radiation for highly efficient glass melting
- Flame length adjustability by a factor of up to 2X at a fixed firing rate
- Optional remote performance monitoring
- Capability to fine tune flame properties such as flame length and momentum to optimize heat transfer

Key HR_x Technology Benefits

The HR_x burner can safely operate with oxygen staging in excess of 95 percent, enabling benefits over air-fuel technology such as:

- Increased flame radiation for high fuel efficiency
- Ultra-low NO_x emissions
- Foam reduction capability for higher-quality glass production
- Enhanced productivity



Melt mode



Split mode



Foam control mode

Optimization of flame properties to achieve different melting objectives are readily enabled by adjustment to convenient staging valves integrated onto the HR_x burner body. Pictured from left to right are the HR_x burner in the Melt (under-staged), Split (dual over/under-staged) and Foam Control (over-staged) operating modes.



Integrated Oxygen Supply/Cleanfire® HR_x™ Burner System

This new offering combines the advantages of economical onsite oxygen supply, integrated with an optimized HR_x burner system, in a full oxy-fuel system for:

- Higher energy efficiency and lower power costs
- Ultra-low NO_x emissions
- Higher glass quality
- Reliable oxy-fuel burner technology that can outlive the duration of the furnace campaign

Cleanfire® HR_x™ Synchronized Boost System

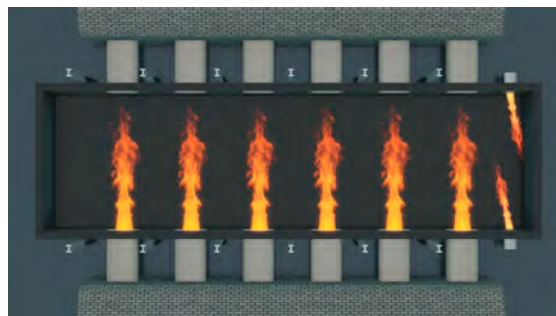
The HR_x Synchronized Boost System was developed to maximize the HR_x burner's efficiency when firing in the turbulent conditions of a side port air-fired furnace. It minimizes the issues associated with furnace turbulence and optimizes the oxy-fuel flame over the incoming batch materials, in tandem with regen burner reversals.

The Synchronized Boost System is comprised of:

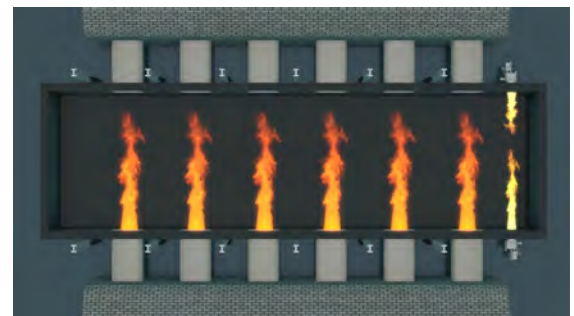
- Two HR_x boost burners with pneumatic actuators on the staging mode and primary oxygen valves
- Two pneumatic control panels (one per burner)
- One PLC panel that contains the control logic for the system

This system has the potential to enhance the benefits of oxy-fuel boosting, allowing for:

- Higher bottom temperatures
- Lower crown temperatures
- Lower defects
- Increased production or fuel savings



Air-fuel with generic
oxy-fuel boost burners



Air-fuel with HR_x
Synchronized Boost System

Hydrogen Blends for Glass Melting

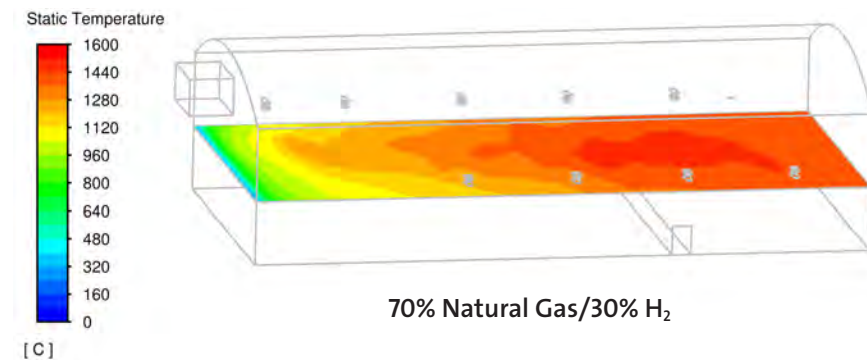
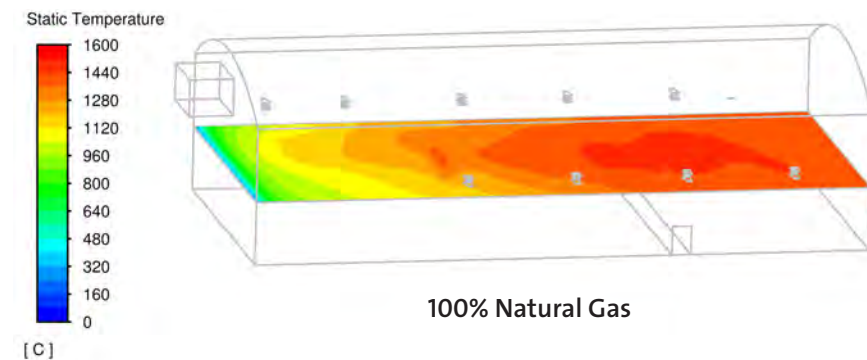
As the glass industry navigates towards zero carbon emissions via increasing hydrogen adoption, the HR_x burner is well equipped to handle combustion of natural gas-H₂ blends, offering its users an immediate path to reducing their carbon footprint without causing:

- Higher breast wall temperatures
- Elevated NO_x emissions
- Glass melting inefficiencies

The state-of-the-art capabilities of the HR_x burner enable the flexibility to handle the key differences in chemical kinetics of H₂ blends, without compromising the widely appreciated operational efficiency and functionalities of the burner. The burner technology continues to evolve and the next generation under development will be tuned to maximize performance with higher H₂ blends (50–100%).

We are confident that the HR_x burner platform will remain a leading technology as the glass industry navigates towards zero carbon emissions via increasing H₂ adoption.

CFD Modeling



CFD simulations confirm that blending up to 30% hydrogen using the HR_x burner doesn't impact the furnace heat transfer profile.

Air Products SMART Technology for Data Monitoring and Process Control

Our HR_x burner systems feature Air Products SMART Technology which uses state-of-the-art on-burner diagnostic sensors and wireless communications technology to monitor and control our gases and equipment as well as track key process parameters. The on-board sensors are a valuable tool to help furnace operators optimize the burner setting for maximum flame staging, foam reduction, or NO_x control.



The Air Products Advantage

Air Products is a global, leading industrial gas supplier. For more than 80 years, primary glass producers have turned to Air Products' continuously evolving portfolio of oxygen solutions to improve combustion and enable additional benefits, including increased glass production, reduced fuel consumption and emissions, and enhanced glass quality. Processed glass producers rely on us for safe and efficient supply and use of nitrogen, oxygen, hydrogen, helium, and argon for a number of applications involved in atmosphere control, forming, assembly, and recycling of products.

Let us help optimize your glass production and decarbonize your process, as we have done for many furnaces all over the world. To help you understand which of the industry-leading HR_x burner systems is a good fit for your operating goals, contact us about a demonstration in our pilot-scale Advanced Clean Energy lab.

**For more information,
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